FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

Linking Food Safety with Health and Nutrition: Insights and Priorities

Feed the Future Innovation Lab for Food Safety

Feb. 24, 2021

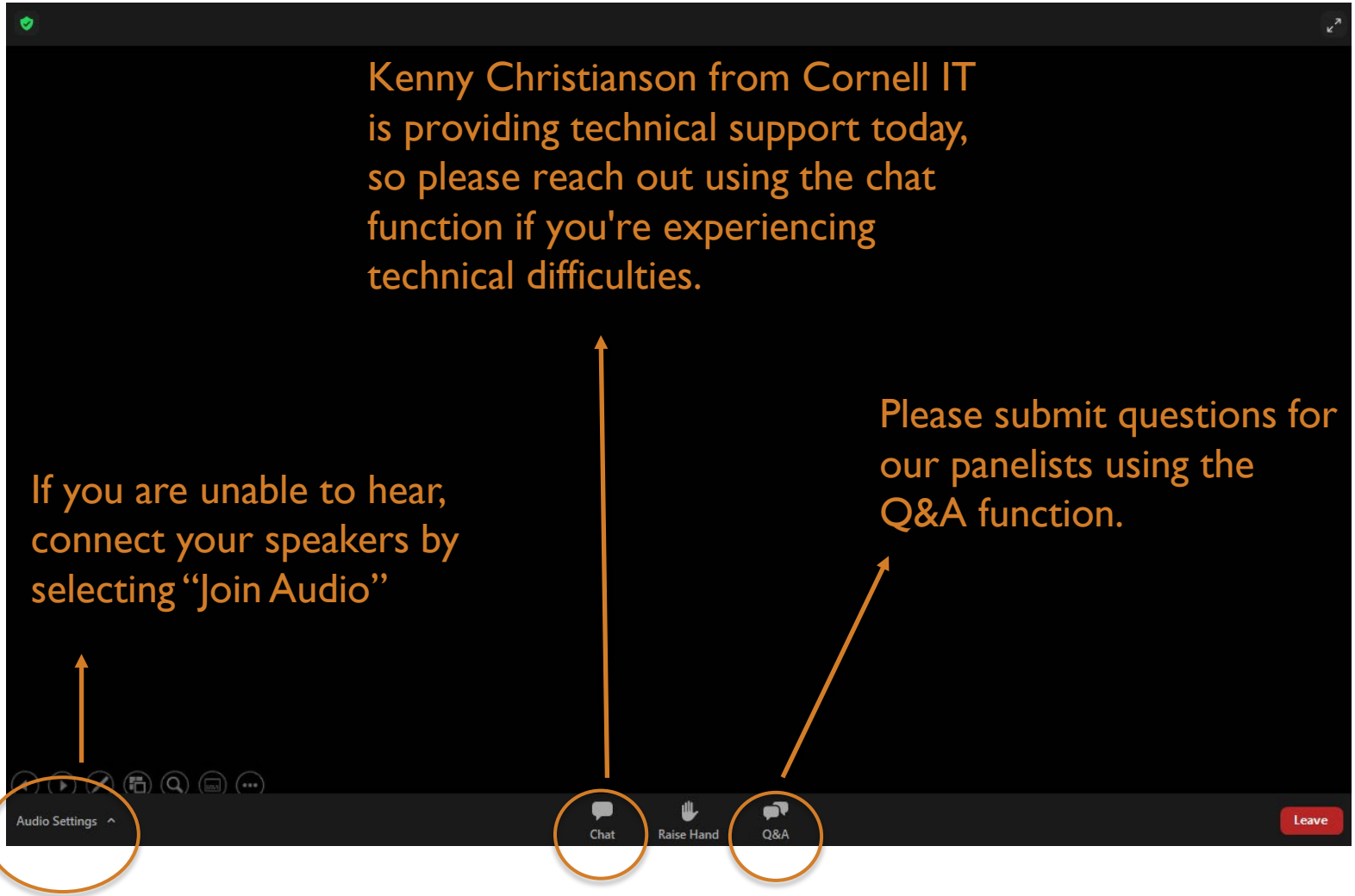
USAID FROM THE AMERICAN PEOPLE

PURDUE UNIVERSITY

Cornell University

FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

WELCOME



FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

MODERATOR

Haley Oliver

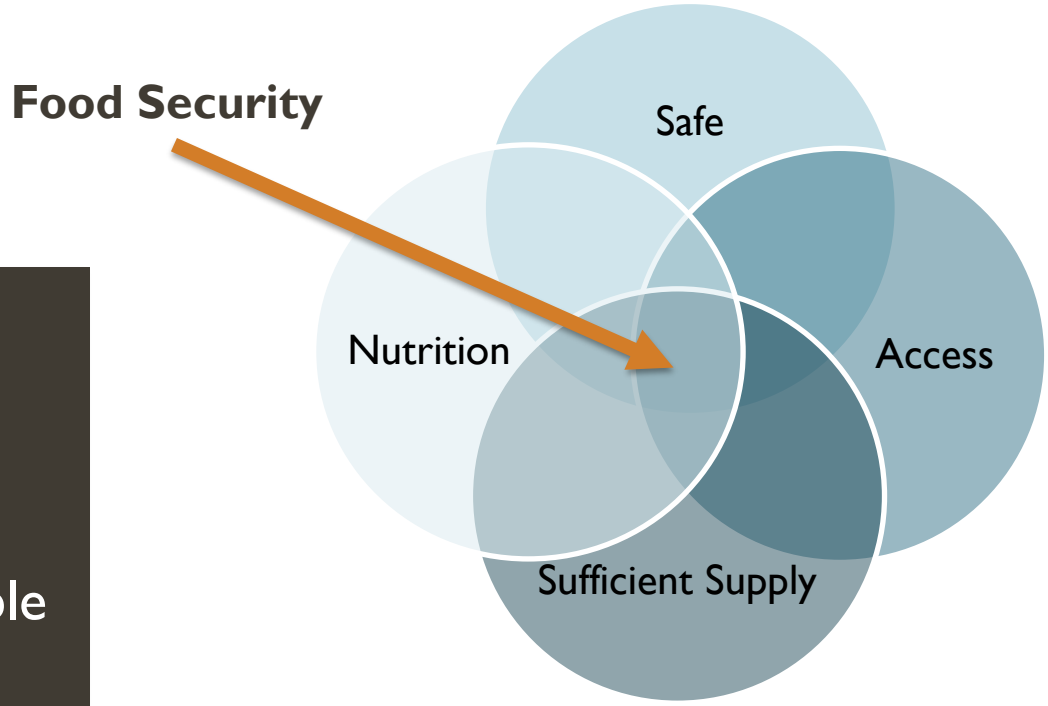
Director of the Feed the Future
Innovation Lab for Food Safety

Professor of Food Science
Purdue University

FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

CONNECTING FOOD SAFETY & FOOD SECURITY

Food security is achieved when foods are safe, nutritious, accessible, and available



USAID FROM THE AMERICAN PEOPLE

PURDUE UNIVERSITY

Cornell University

Unsafe food creates a cycle of disease and malnutrition, particularly affecting infants, young children, elderly and sick

FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

AGENDA

- **Shanda Steimer – 10 min.**
  U.S. Agency for International Development (USAID)
- **Patrick Webb – 10 min.**
  Feed the Future Innovation Lab for Nutrition
  Tufts University
- **Prabhu Pingali – 10 min.**
  Tata-Cornell Institute for Agriculture and Nutrition
  Cornell University
- **Jessie Vipham – 10 min.**
  Kansas State University
- **Panel discussion – 30 min.**

FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

SPEAKER

Shanda Steimer

Director of the Center for Nutrition
Bureau for Resilience and Food Security
United States Agency for International Development (USAID)

FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

SPEAKER

Patrick Webb

Director of the Feed the Future
Innovation Lab for Nutrition

Alexander McFarlane Professor
at the Friedman School of Nutrition
Tufts University

FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

Linking Food Safety with Health and Nutrition

Food Safety from a Nutrition Perspective

Patrick Webb

February 2021

USAID
FROM THE AMERICAN PEOPLE

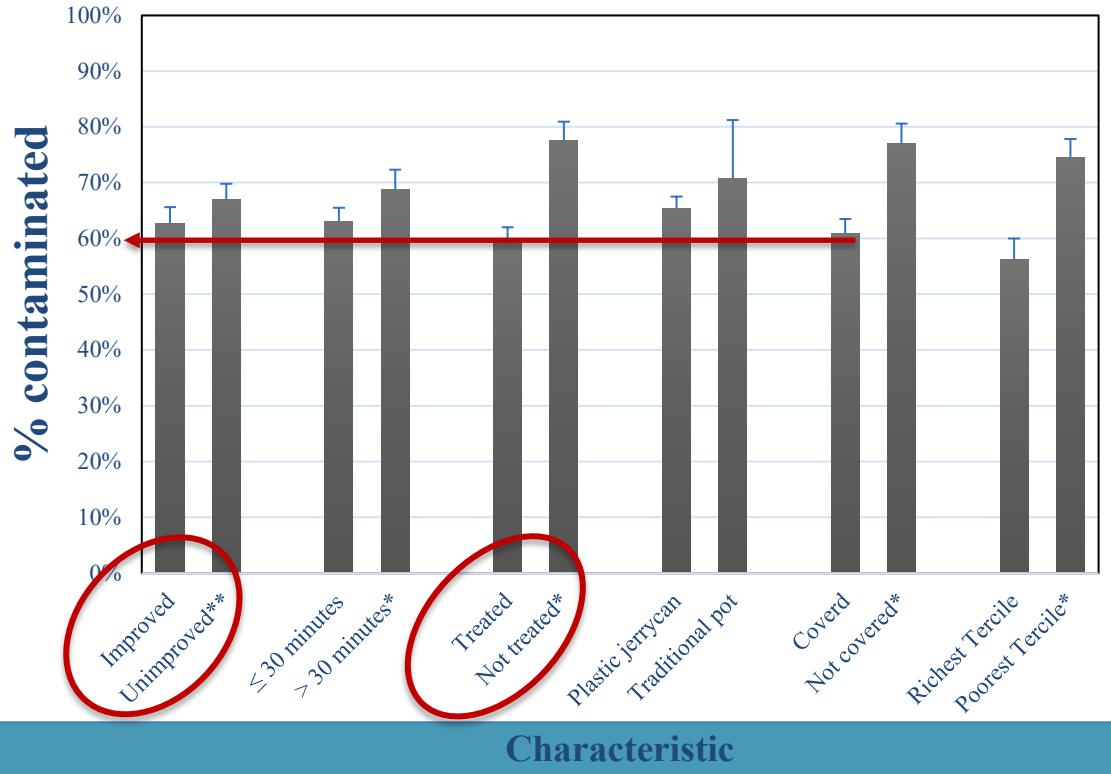
Feed the Future Innovation Lab for Nutrition

Tufts UNIVERSITY | GERALD J. AND DOROTHY R. Friedman School of Nutrition Science and Policy

Water safety matters for health *and* nutrition

- *E. coli* contamination of 'treated', 'covered' or 'improved' water sources almost as bad as unimproved.

Birth cohort in SW **Uganda** [n = 2,022 households]



Source: Lauer et al. 2018

Water safety matters for health *and* nutrition

- More *E. coli* linked to more EED in child.
- More EED in child associated with stunting and wasting.

SW **Uganda** birth cohort (n=365 children <5y)

Outcome	Unadjusted linear regression models	Adjusted linear regression models
Growth at birth		
Stunted (n = 90)	1.88 (1.23, 2.89)*	1.68 (1.22, 2.32)*
Underweight (n = 9)	0.98 (0.35, 2.76)	0.78 (0.28, 2.18)
Growth at 6 months		
Stunted (n = 86)	2.31 (1.40, 3.81)*	1.70 (1.21, 2.37)*
Underweight (n = 25)	1.70 (0.77, 3.74)	1.35 (0.61, 3.00)
Growth at 9 months		
Stunted (n = 102)	1.66 (0.94, 2.93)	1.34 (0.88, 2.02)
Underweight (n = 31)	2.36 (1.49, 3.72)*	1.81 (0.92, 3.54)
Growth at L:M test (12–16 months)		
Stunted (n = 135)	1.67 (1.10, 2.53)*	1.38 (0.88, 2.18)
Underweight (n = 34)	1.29 (0.81, 2.05)	1.10 (0.61, 1.95)

Cells present odds ratio (OR) and 95% confidence interval, * *P*-value < 0.05

Source: Lauer et al. 2018. *Am Jou Trop. Med.*

FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

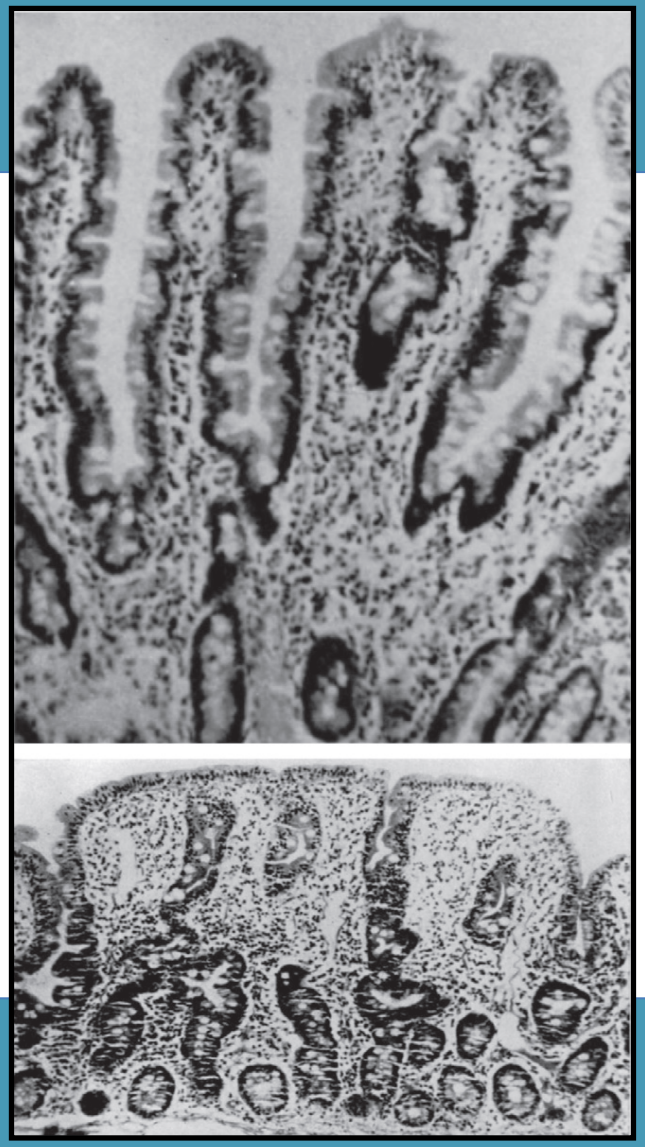
Nipah virus spillover to humans from bats

Raw date palm sap

USAID
FROM THE AMERICAN PEOPLE

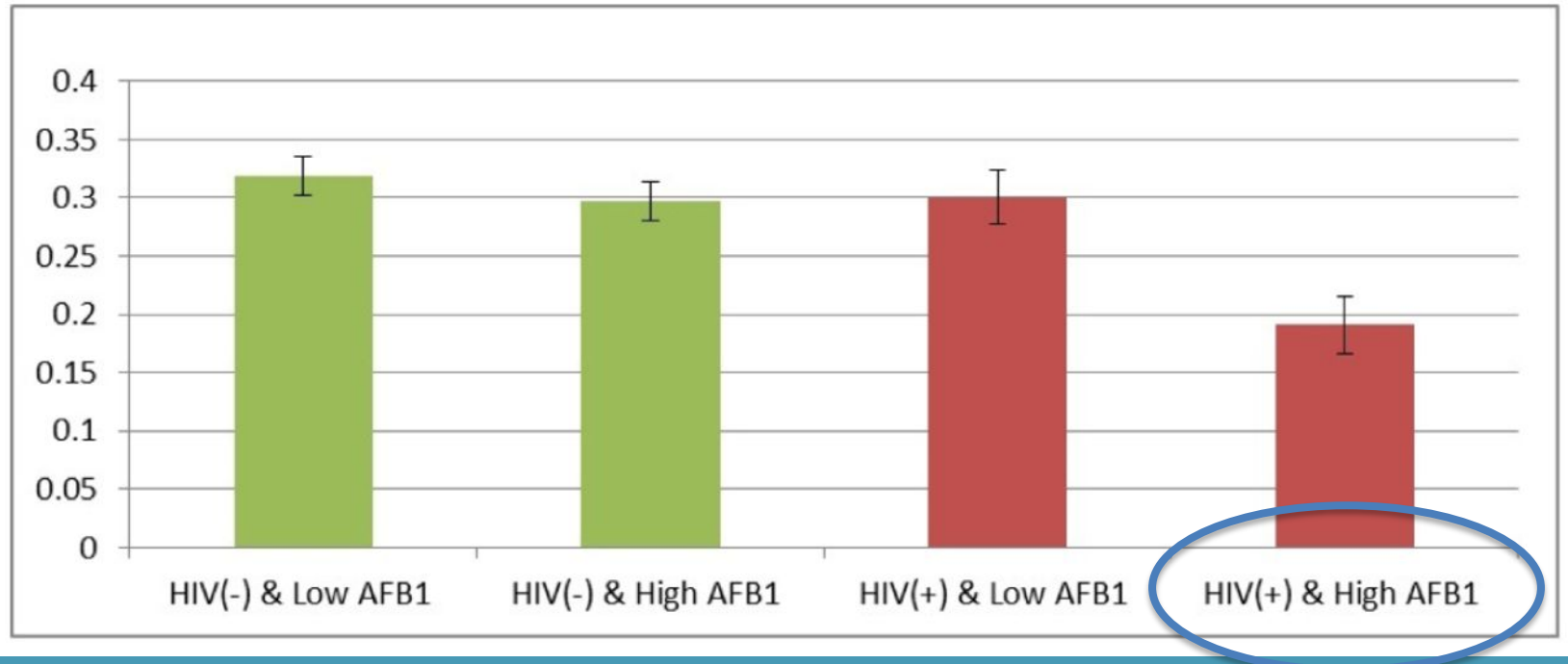
Tufts UNIVERSITY | GERALD J. AND DOROTHY R. Friedman School of Nutrition Science and Policy

- Globally 144 million children still stunted.
- Suggestion of link to mycotoxins.
- Access to poor quality diet = more intake of mycotoxins
- Food safety is therefore a major concern for nutrition



Rate of weight gain (kg/week) during pregnancy

GULU UGANDA (N=246)



Source: Barnabas Kahiira Natamba et al. FASEB Journal 2016;30:432.6

MATERNAL AFLATOXIN AND BIRTH OUTCOMES

	Uganda (N=3200)	Uganda (N=220)	Nepal (N=1675)
Dependent Variables	β estimate / OR	β estimate / OR	β estimate / OR
Birth weight (kg)	**-0.023 (0.009)****	**-0.07****	NS
Weight-for-age Z score	**-0.054 (0.018)*****	**-0.16****	NS
Small for Gest. Age (%)	**1.1408****	NA	**1.13****
Stunting at birth (%)	**1.0911****	NS	NS
Head Circumference	NS	**-0.07****	NA
Head Circum./age	NS	**-0.23****	NA

*p<0.05, ** p<0.01, *** p<0.001

OR = Odds Ratio

AFB1 AND CHILD GROWTH (3 MONTHS - 22 MONTHS) IN NEPAL

	Length (cm) β	LAZ β	Stunting Odds Ratio
(Ln) aflatoxin B1-lysine adduct [1]	-0.19 (-0.29, -0.09)**	-0.05 (-0.09, -0.02)**	1.34 (1.02, 1.77)*
(Ln) aflatoxin B1-lysine adduct/kg weight [2]	-0.26 (-0.33, -0.18)**	-0.08 (-0.11, -0.05)**	1.27 (1.02, 1.59)*

Significant negative associations between AFB1 concentrations, length, LAZ and odds of stunting.

*p<0.05, ** p<0.01, *** p<0.001

Andrews-Trevino et al. (2020) "Aflatoxin exposure and child nutrition: measuring anthropometric and long-bone growth over time in Nepal" – Submitted to AJCN

Summary of Findings

Birth Cohort: **Uganda**

i. Blood aflatoxin in pregnant women significantly negative effect on a) gestational weight gain, b) weight-for-age at birth, c) stunting at birth, and d) head circumference at birth.

ii. Maternal HIV/AIDS infection appears to exacerbate these effects on pregnancy outcomes.

Birth Cohort: **Nepal**

i. Even low aflatoxin levels in pregnant women's blood significantly linked to low SGA.

ii. Levels rise as a child ages, regardless of income, education or location.

CONCLUSIONS

- A *clean food* environment matters at least as much as clean water.
- New evidence now directly implicates mycotoxins with poor birth outcomes and subsequent child stunting.
- Food safety represents a major contribution to nutrition, not only to health and consumer trust.

FEED THE FUTURE

The U.S. Government's Global Hunger & Food Security Initiative

www.feedthefuture.gov

USAID
FROM THE AMERICAN PEOPLE

Tufts UNIVERSITY | GERALD J. AND DOROTHY R. Friedman School of Nutrition Science and Policy

FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

SPEAKER

Prabhu Pingali

Director of the Tata-Cornell Institute for Agriculture and Nutrition

Professor in the Charles H. Dyson School of Applied Economics and Management
Cornell University

Tata Cornell Institute

Cornell University

Food Safety in India

Prabhu Pingali

Professor Applied Economics & Director of the Tata-Cornell Institute

Dyson School of Applied Economics and Management

Cornell University, Ithaca USA

February 24, 2021

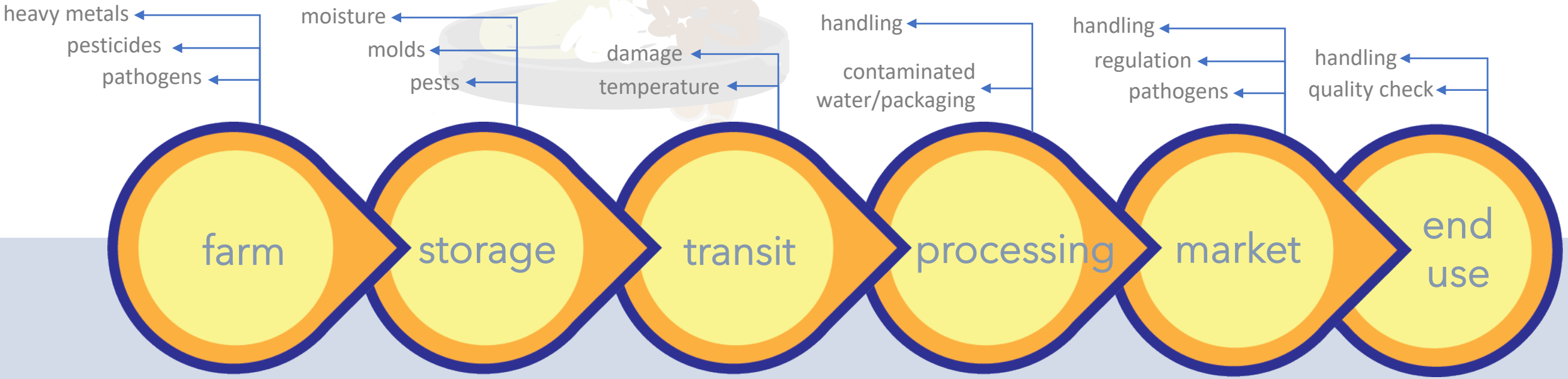
Food safety in the Indian context

- **Foodborne illness is widespread**, with ~100 million cases in India annually (this is a conservative estimate, as these illnesses are under-reported)
- By 2030, **one out of every nine people in India** will fall sick with a foodborne disease (Kristkova et al., 2017)
- **At population-scale**: Risk increases with wealth (higher GDP → more meat/perishables consumption → more foodborne disease)
- **Within populations**: Poor food safety practices are associated with low incomes and poverty (Reddy et al., 2020)

I need fruits, vegetables, and animal protein to feed my family!

there are numerous risks throughout the value chain

- India's growing middle class is increasing the demand for perishables
- policies and practices required to ensure that safe food reaches the consumer are underdeveloped
- food safety risks persist throughout the value chain from farm to urban consumer



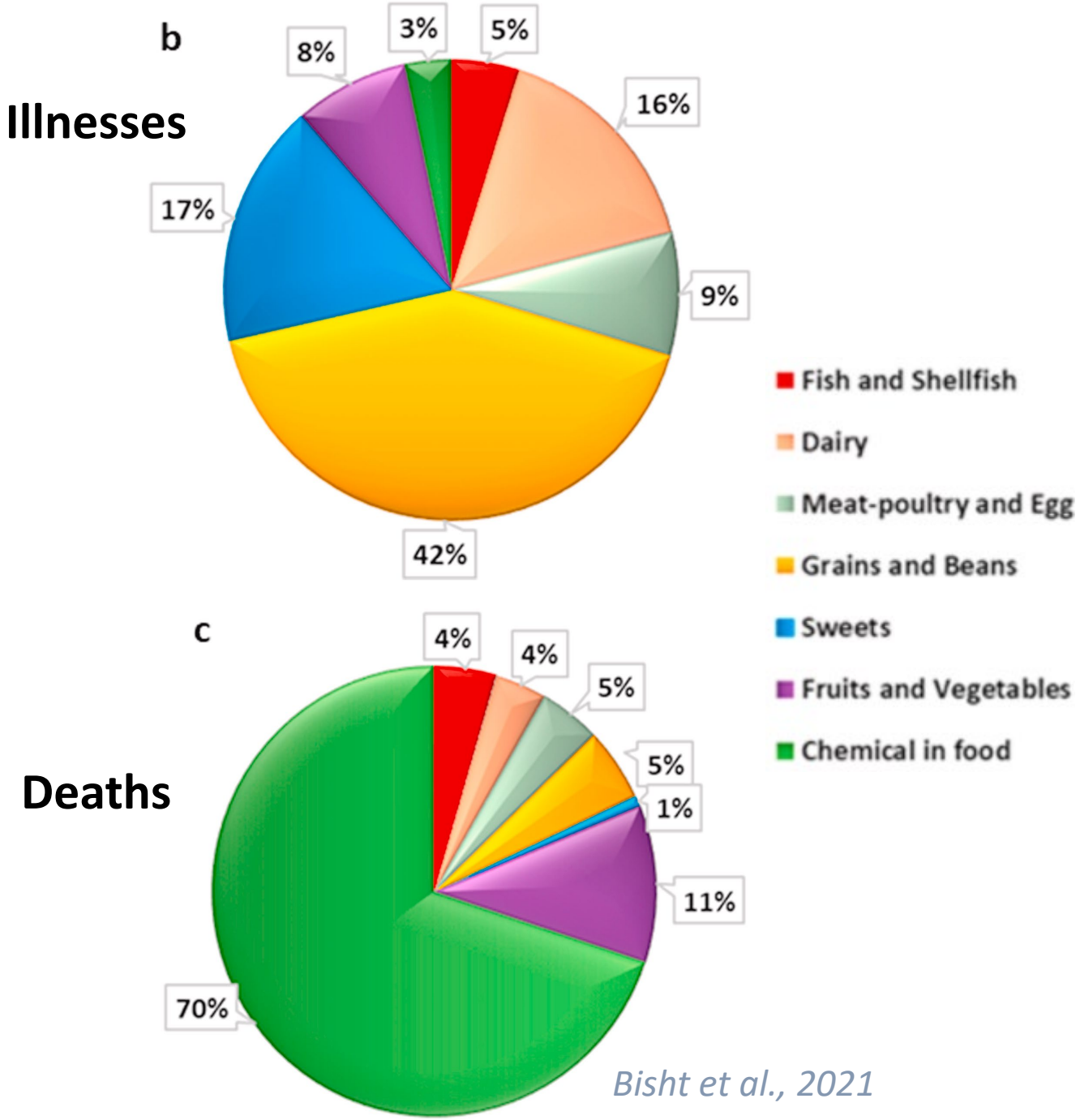
Major food safety threats in India

- **Bacteria** (*E. coli, Salmonella,* etc.; Khare et al., 2018)
- **Pesticide residues** (Srivastava et al., 2010; Gill et al., 2020)
- **Heavy metals** (Sharma et al., 2018; Marshall et al., 2003)
- **Mycotoxins** (Groopman et al., 2014; Wenndt et al., 2020; Bhat et al., 1997)

Linkages between food safety and nutrition

- **Diarrheal disease burden is high**
  - Caused by pathogenic microbes in food and water
  - Major cause of malnutrition and mortality in India (Nilima et al., 2018)
- **Environmental Enteropathy (EE) is an emerging concern**
  - Exposure to toxins in the environment, including via food
  - EE associated with growth impairment and intestinal permeability in India and elsewhere (McKay et al., 2010)
- **Trade-off between safe and nutritious foods**
  - ***Example:*** aquaculture fish can be a good source of protein for the poor in India, but also contribute heavy metal toxins to the diet (Marriott et al., 2020)

Sources of foodborne disease in India



Bisht et al., 2021

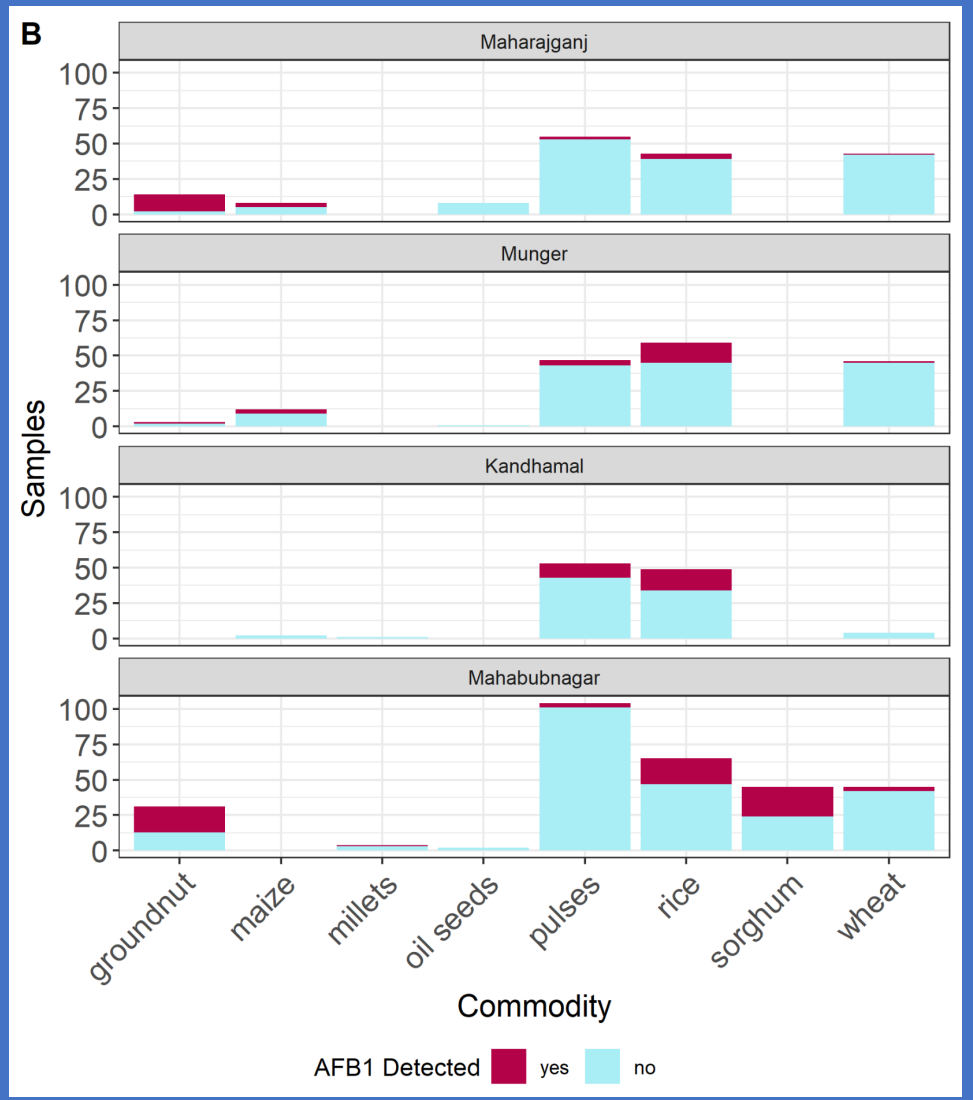
Mycotoxin case study reveals the importance of food systems thinking

- Certain crops such as maize, groundnut, and millet are more prone to contamination than others
- Some communities' diets are substantially riskier than others
- The consumption of unsafe foods can be variable across seasons

Thus: the risk of food safety-related health and nutrition adversity is shouldered disproportionately by some vulnerable sub-populations

- Surveillance and regulatory systems must adequately identify and address these food system dynamics

Aflatoxin detection rates across stored food items in four Indian food systems



Wenndt et al., 2020

Food safety regulation in India

- **Food Safety & Standard Authority of India** (FSSAI) is the major regulatory body
  - Emerging from the Food Safety & Standards Act, 2006
  - Regulates many contaminants associated with foodborne illness
- Current local "regulated markets" or ***mandis*** **are not adequate for preserving quality** or enabling traceability of safety concerns (Deininger & Sur, 2007)
- **Smallholder farmers engaged in self-provisioning have virtually no access to regulatory services** or food safety-related information

Necessary actions to reduce food safety risk across the value chain

good agronomy and varieties

effective, accessible post-harvest technology

develop cold chain systems

compliant practices and facilities

regulation and quality premiums

demand safe, high-quality produce

farm

storage

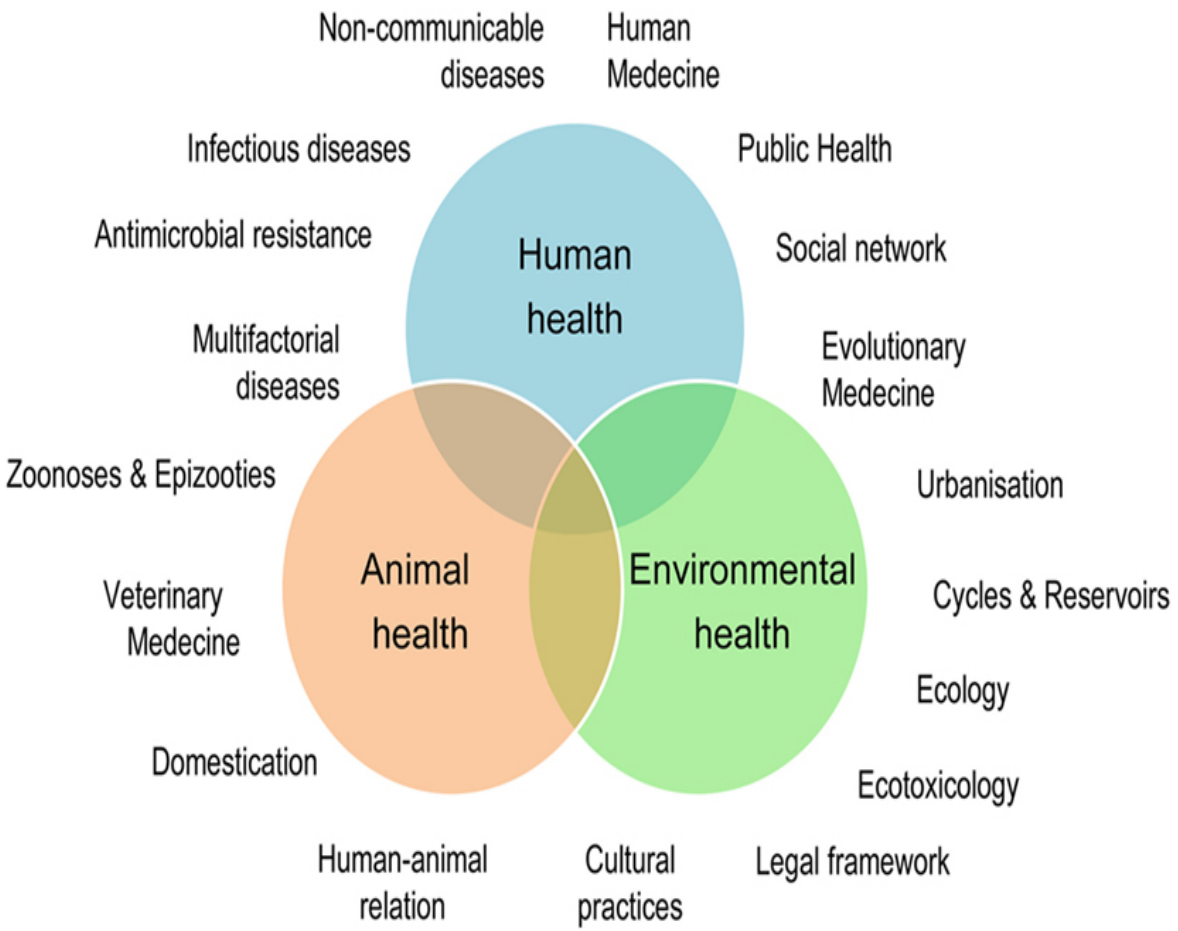
transit

processing

market

end use

A “one health” approach to improving food safety



Destoumieux-Garzon et al., 2018

- Improve **plant health and agronomy** to reduce populations of pathogenic and toxigenic micro-organisms
- Improve **animal production and distribution systems**, along with veterinary medicine, to prevent disease outbreaks
- Improve environmental and infrastructural **constraints to proper food storage and hygiene**
- Improve **messaging and awareness at the grassroots level** and throughout value chains to boost detection and prevention

FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

SPEAKER

Jessie Vipham

Assistant Professor of Food Microbiology and Food Safety
Kansas State University

FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

Nutritious Food for All? The Role of Fresh Food Markets in Nutrition and Food Safety

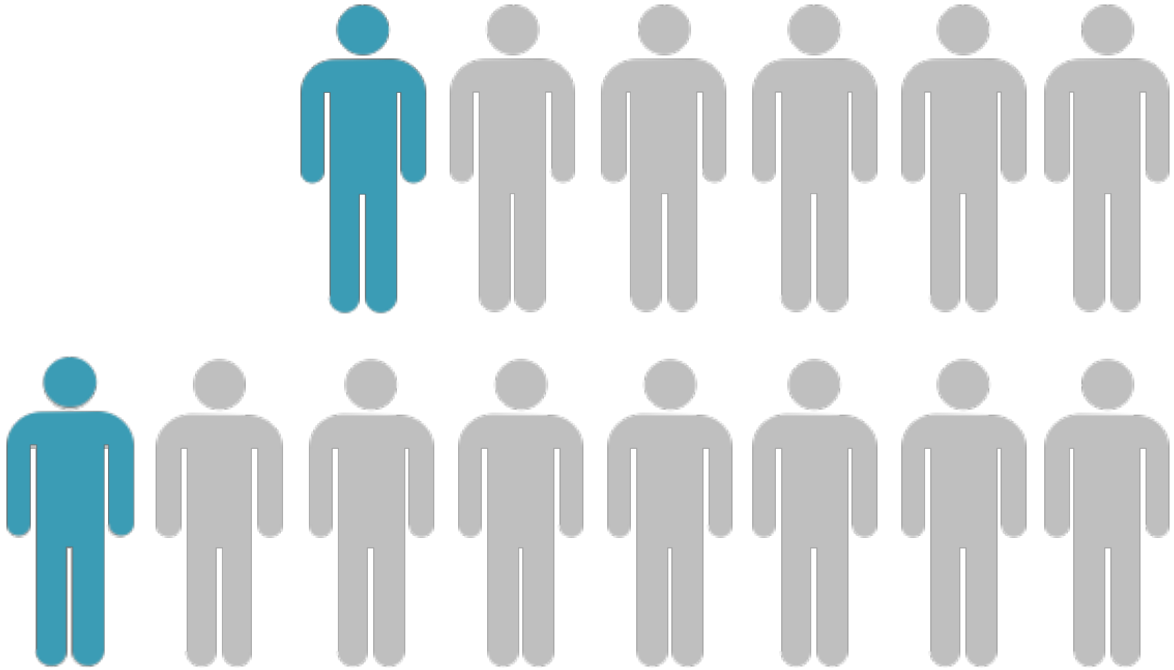
February 24, 2021 FSIL Webinar Series

Jessie L. Vipham, Assistant Professor, Kansas State University

USAID FROM THE AMERICAN PEOPLE
PURDUE UNIVERSITY
KANSAS STATE UNIVERSITY
Institut Pasteur du Cambodge
I.T.C. INSTITUT DE TECHNOLOGIE DU CAMBODGE

FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

THE NEXUS OF FOOD INSECURITY AND FOOD SAFETY



1 in 5
people are food insecure

1 in 8
people suffer foodborne illness

USAID FROM THE AMERICAN PEOPLE
PURDUE UNIVERSITY
KANSAS STATE UNIVERSITY
Institut Pasteur du Cambodge

FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

THE NEXUS OF FOOD INSECURITY AND FOOD SAFETY

Food insecure and the available food is unsafe

USAID FROM THE AMERICAN PEOPLE
PURDUE UNIVERSITY
KANSAS STATE UNIVERSITY
Institut Pasteur du Cambodge

FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

NUTRITIOUS FOOD FOR ALL

- Global nutrition initiatives encourage the consumption of nutrient rich foods.
- Fresh food markets can provide physical access to locally available, nutritious foods.
- Nutrient rich foods (animal source foods/raw fruits and vegetables) are common high-risk foods in terms of food safety.
- Fresh food markets commonly lack basic food safety handling practices, sanitation, and infrastructure.

USAID FROM THE AMERICAN PEOPLE
PURDUE UNIVERSITY
KANSAS STATE UNIVERSITY
Institut Pasteur du Cambodge

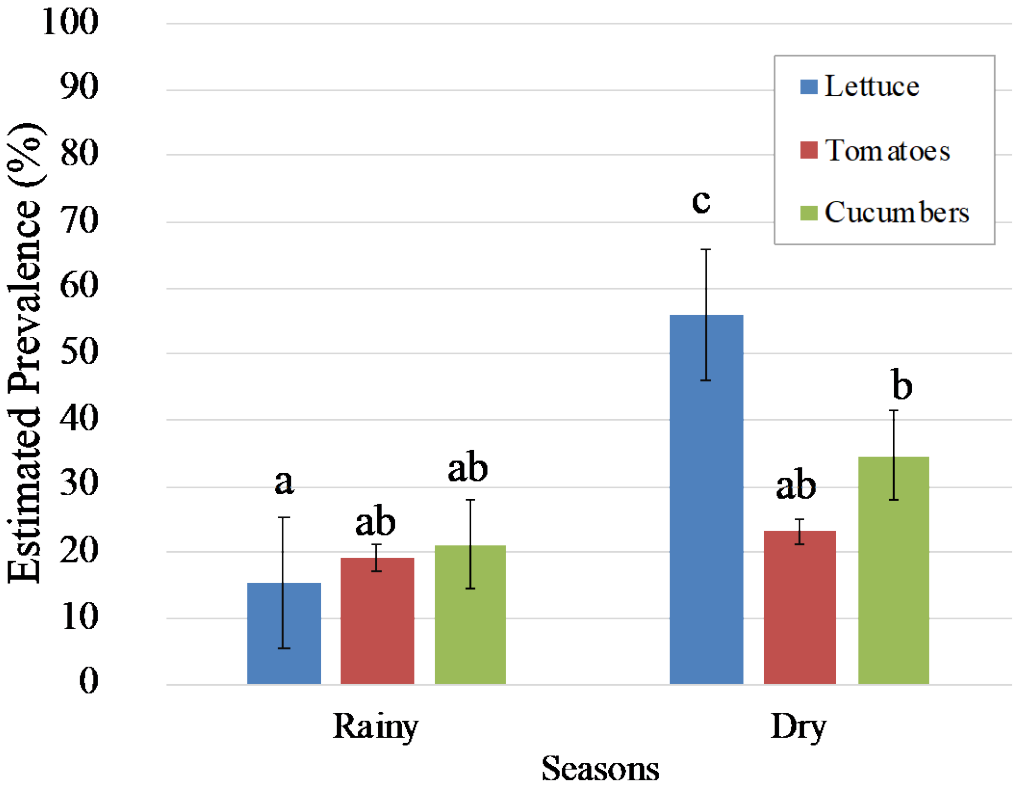
FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

Lessons Learned: Findings on Non-typhoidal *Salmonella enterica* from Fresh Food Markets in Cambodia

USAID FROM THE AMERICAN PEOPLE
PURDUE UNIVERSITY
KANSAS STATE UNIVERSITY
Institut Pasteur du Cambodge

FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

Prevalence of *Salmonella enterica* from Vegetable Samples



- *Salmonella* was isolated from 28.2% of total samples (312).
- Fresh food markets are the final point in the value-chain before raw vegetables reach consumers.
- Consumption of contaminated raw vegetables pose a risk to human health.

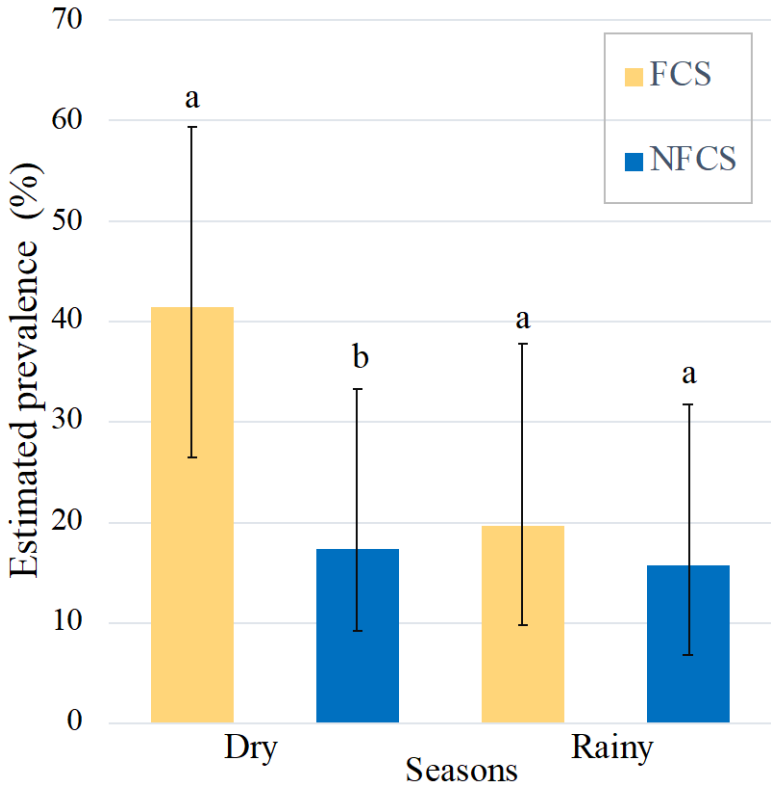
Figure 1. Prevalence of *Salmonella enterica* on vegetables sold in Cambodian informal markets collected at two different seasons. Different letters indicate significant differences between groups ($P<0.05$).

Desiree K, Schwan C.L., L. V, Hok L, Bello N.M., Nwadike L, Phebus R.K., Vipham J.L. Investigating *Salmonella enterica*, generic *Escherichia coli* (E. coli) and Coliforms on Fresh Vegetables Sold in Informal Markets in Cambodia. *J Food Prot*. 2020 Dec 15. doi: 10.4315/JFP-20-219. Epub ahead of print. PMID: 33320940.

USAID FROM THE AMERICAN PEOPLE
PURDUE UNIVERSITY
KANSAS STATE UNIVERSITY
Institut Pasteur du Cambodge

FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

Prevalence of *Salmonella enterica* from Environmental Surfaces



- *Salmonella* was isolated from multiple market surfaces.
- Seasonal data mimicked vegetable-level data, with the highest prevalence being observed on food contact surfaces in the dry season.
- Market conditions and environmental surface data suggests a high potential for cross-contamination within markets.

Figure 2. Estimated prevalence of *Salmonella enterica* (and corresponding 95% confidence intervals) on food contact surfaces (FCS) and non-food-contact surfaces (NFCS) during dry and rainy seasons. (a,b). Letters indicate significant differences between surface types within each season at alpha = 0.05.

Schwan, C.L., K. Desiree, N. M. Bello, L. Bastos, L. Hok, R. K. Phebus, S. Gragg, J. Kastner, and J. L. Vipham. "Prevalence of *Salmonella Enterica* Isolated from Food Contact and Non-Food Contact Surfaces in Cambodian Informal Markets." *Journal of Food Protection*, August 27, 2020. https://doi.org/10.4315/JFP-20-112.

USAID FROM THE AMERICAN PEOPLE
PURDUE UNIVERSITY
KANSAS STATE UNIVERSITY
Institut Pasteur du Cambodge

FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

Serotype Distribution of *Salmonella enterica* Isolates

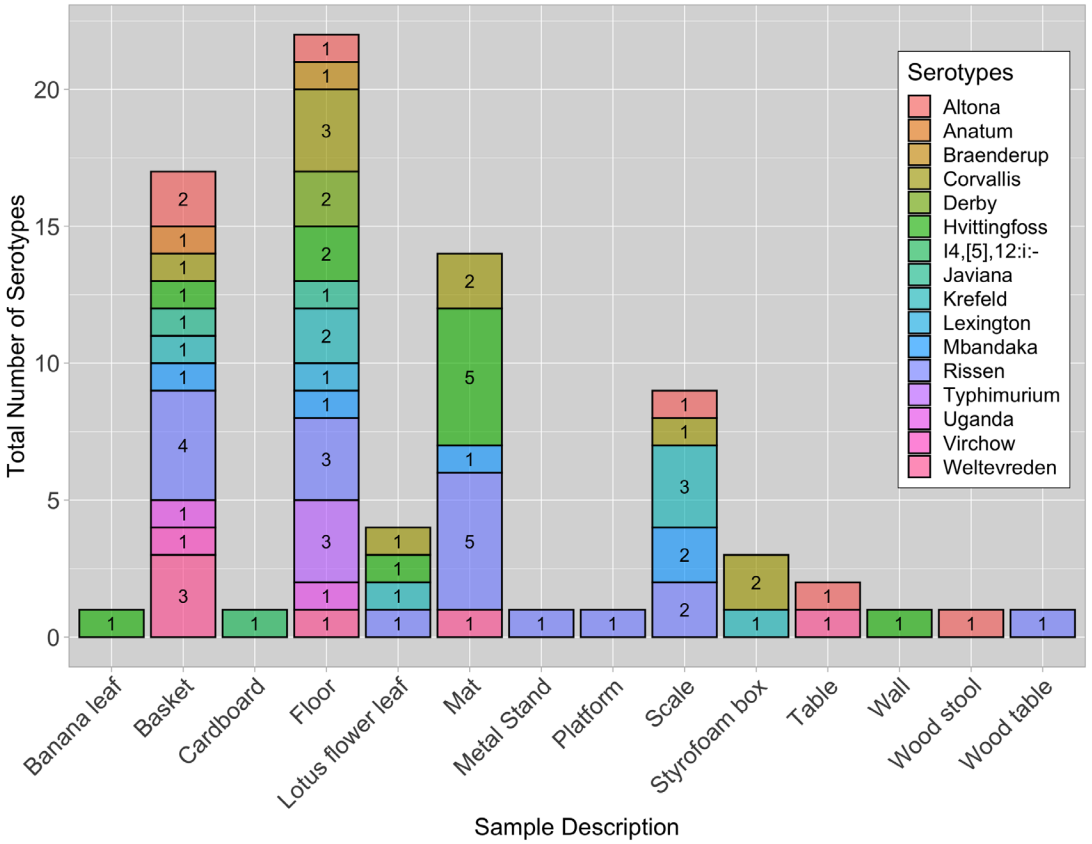


Figure 3. Diversity of the 16 serotypes of *Salmonella enterica* detected in various sample types.

- High serotype and surface type diversity may suggest multiple points of contamination.
- *Salmonella* Rissen, *Salmonella* Hvittingfoss, and *Salmonella* Corvallis were the most prevalent serotypes.
- *Salmonella* Corvallis has been isolated from clinical samples of multiple patients with travel history to South East Asia (United Kingdom, Japan, U.S. and Thailand).

USAID FROM THE AMERICAN PEOPLE
PURDUE UNIVERSITY
KANSAS STATE UNIVERSITY
Institut Pasteur du Cambodge

But do they cause disease?

13 SNPs

Source:https://www.ncbi.nlm.nih.gov/pathogens/isolates#/search/SAMN13322378

FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

IS IT TIME FOR A *CLEAN REVOLUTION*?

Food safety provides strong opportunities for improved outcomes in public health and agriculture productivity. However, there is a need for future research and development initiatives to:

- Focus on sanitary design, sanitation and handling practices, and functional food safety networks.
- Promote holistic public health outcomes.
- Develop national technical experts, with an emphasis on data scientists.
- Invest in national surveillance and monitoring programs.

USAID FROM THE AMERICAN PEOPLE
PURDUE UNIVERSITY
KANSAS STATE UNIVERSITY
Institut Pasteur du Cambodge
I.T.C. INSTITUT DE TECHNOLOGIE DU CAMBODGE

FEED THE FUTURE

The U.S. Government's Global Hunger & Food Security Initiative

USAID FROM THE AMERICAN PEOPLE

PURDUE UNIVERSITY

KANSAS STATE UNIVERSITY

Institut Pasteur du Cambodge

I.T.C. INSTITUT DE TECHNOLOGIE DU CAMBODGE

FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

LINKING FOOD SAFETY WITH HEALTH AND NUTRITION: INSIGHTS AND PRIORITIES

Panel Discussion

Shanda Steimer
USAID Perspective on Food Safety and Nutrition

Patrick Webb
Food Safety from a Nutrition Perspective

Prabhu Pingali
Food Safety in the Indian Context

Jessie Vipham
Fresh Food Markets in Nutrition and Food Safety

USAID FROM THE AMERICAN PEOPLE

PURDUE UNIVERSITY

Cornell University

FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

THANK YOU

A link to the recording and presentations will be emailed to attendees next week

Feed the Future Innovation Lab for Food Safety

USAID FROM THE AMERICAN PEOPLE

PURDUE UNIVERSITY

Cornell University

FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

Next webinar:

Food Safety and Private Sector Partnerships
March 16 9-10:30 EDT

- **Kelly Cormier**
  USAID Center for Nutrition
- **Thoric Cederstrom**
  Food Enterprise Solutions
- **Greg Grothe**
  Land O'Lakes Venture 37
- **Howard Popoola**
  Kroger

FEED THE FUTURE

The U.S. Government's Global Hunger & Food Security Initiative

USAID
FROM THE AMERICAN PEOPLE

PURDUE UNIVERSITY

Cornell University